CHAPTER 3

PRELIMINARY ZINC ANALYSIS AT OFFSHORE WIND FARMS

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Abstract

Recent studies have listed potential contamination by chemical emissions of metals and organic compounds related to offshore wind farms. Aluminium (Al), zinc (Zn) and indium (In) are metals used for corrosion protection in sacrificial anodes. As Zn concentrations have increased at the Belgian part of the North Sea (BPNS) over the past decades, a first indicative and preliminary test was set up to measure Zn concentrations in the sediment from wind farms in the BPNS. Zn concentrations from nearby (37.5 m) and far (300-500 m) samples near four wind turbines on the Bligh Bank and Thornton Bank were lower than those in the nearby reference zone on the Goote Bank, with no significant difference between nearby and far sediment samples. More extensive research is needed to further validate the results and to unravel the potential emission of other metals and organic compounds from wind farms.

1. Introduction

Although wind energy is considered a green energy source, environmental impact may not be excluded. Whereas many studies have focused on the impact of offshore wind farms on the biodiversity, chemical emissions are less studied (Kirchgeorg *et al.* 2018). Chemical emissions can be divided in contamination by metals and by organic compounds. Metal emissions may originate from corrosion protection systems, such as sacrificial anodes, and include aluminium (Al), zinc (Zn) and indium (In) (Kirchgeorg *et al.* 2018; Tornero & Hanke 2016). Contamination of organic compounds may originate from increased vessel traffic and potential spillovers or from routine and maintenance activities, including leaching from antifouling paints or from hydraulic fluids and lubricant oils. Potential organic contaminants related to these activities are booster biocides, bisphenols, hydrocarbons such as BTEX and PAHs, silicone fluids, mineral oils, biodiesel, natural vegetable oils and synthetic esters, coolants and electrolytes (Tornero & Hanke 2016; Kirchgeorg *et al.* 2018). Although chemical emissions from offshore wind farms are probably low compared to other offshore activities, they can become relevant with increasing number of wind farms. Available data is scarce, making it currently difficult to assess the impact of these chemical emissions on the marine environment (Kirchgeorg *et al.* 2018).

Zn concentrations have increased in the Belgian part of the North Sea (BPNS) over the past decades (Lagring *et al.* 2018). Therefore, a first indicative and preliminary test was set up to measure Zn concentrations in and around offshore wind farms at the BPNS.

Table 1. Sediment sample coordinates with zone (NEAR) at about 37.5 m from the specified wind turbine, zone (FAR) at about 350-500 m from the specified wind turbine and zone (REF) reference zone

Sample	Wind turbine	Zone	Latitude	Longitude	Location
BB9_ZEERDICHT	BB9	NEAR	51°39.79357'N	2°47.88500'E	Bligh Bank
BB9_VER	BB9	FAR	51°39.89838'N	2°48.15348'E	Bligh Bank
TB7_ZEERDICHT	TB7	NEAR	51°33.12130'N	2°57.98891'E	Thornton Bank
TB13_VER	TB13	FAR	51°33.30576'N	2°58.26396'E	Thornton Bank
TB15_ZEERDICHT	TB15	NEAR	51°32.00005'N	2°55.47882'E	Thornton Bank
TB24_VER	TB24	FAR	51°32.24592'N	2°55.48956'E	Thornton Bank
BGR 2	-	REF	51°27.51944'N	2°54.51424'E	Goote Bank
BGR 19	-	REF	51°27.76585'N	2°50.84924'E	Goote Bank

2. Material and methods

Sediment samples were taken by the Marine Biology Research Group of Ghent University in autumn 2017 with the RV Simon Stevin (VLIZ) and Aquatrot (OMS) by using a Van Veen grab. For heavy metal analysis, an insertion tube of about 4-5 cm inner diameter was used to take a cross-section of the Van Veen grab sample. By this sampling technique, Zn concentrations were measured in the total sediment sample, supposing chemical equilibrium between the sediment and the interstitial water. Samples were taken about 37.5 m (NEAR) and 350-500 m (FAR) away from five specified wind turbines at the Bligh Bank (Belwind) and Thornton Bank (C-power) (table 1). Two reference locations (REF) were selected at the nearby Goote Bank, suggested as a useful reference area in De Maersschalck *et al.* (2005).

Samples were analysed by Sciensano, Service Trace Elements and Nanomaterials, for their Zn concentration. Total freeze-dried sediment samples were digested in Teflon bombs with a mixture of concentrated $HClO_4$, HNO_3 and HF at 170° C for 16 h. Dry residues were dissolved in HNO_3 prior to analysis with ICP-OES (De Witte *et al.* 2016). In contrast to the OSPAR assessment approach (OSPAR, 2011), Zn data is not normalised to aluminium, as Al can be a contaminant at offshore wind farms (Kirchgeorg *et al.* 2018).

3. Results

First indicative results do not seem to reveal higher Zn values in the direct neighbourhood of the wind turbines. On the contrary, concentrations inside both wind farms (average 4.6 ± 1.0 $mg.kg^{-1}$) are almost 60% lower than those in the reference zone on the Goote Bank (average 11.1 ± 1.1 $mg.kg^{-1}$). No clear difference was noted between nearby and far samples (on average 4.4 ± 1.2 $mg.kg^{-1}$ at 37.5 m *vs.* 4.9 ± 0.8 $mg.kg^{-1}$ at 500 m distance from the wind turbines).

4. Discussion

In this experimental design, Zn contamination measurements were performed as an indicative and preliminary test. Zn was selected as target compound as it is applied at wind farms for corrosion protection, and Zn values have been shown to rise over the last decades in the BPNS (Lagring *et al.* 2018).

The studies of Kirchgeorg *et al.* (2018) and Tornero & Hanke (2016) indicate that chemical emissions may be relevant at offshore wind farms. This first preliminary test does not reveal high(er) Zn concentrations at wind farms in the BPNS. However, the set-up of this study was too limited to conclude that Zn concentrations have not increased by offshore wind farms, as it is not investigated why concentrations at the Goote Bank are higher. More research on Zn contamination

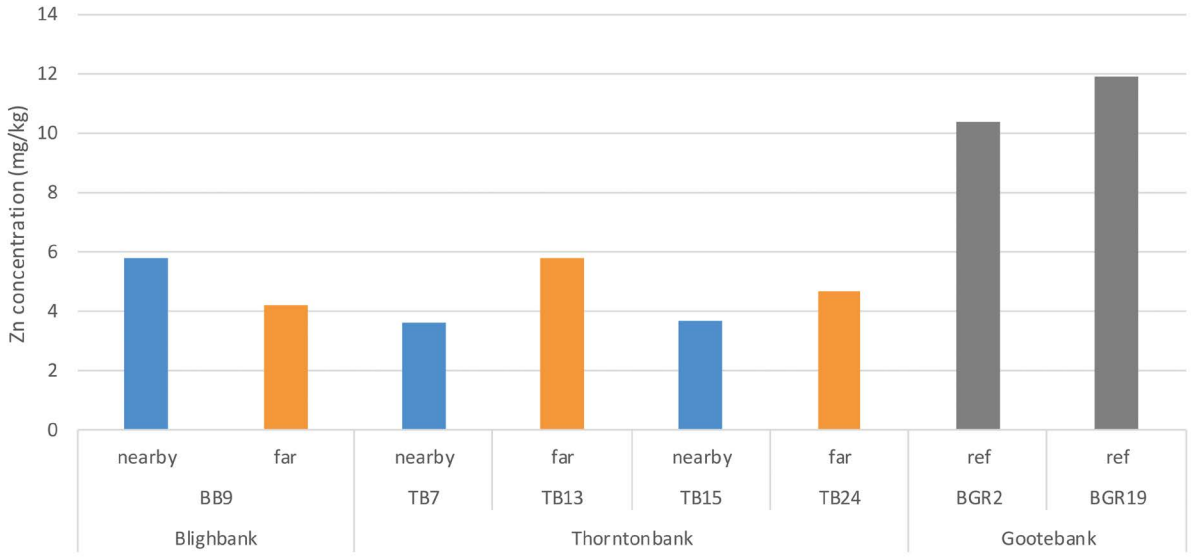

Figure 1. Zn concentrations in sediment samples at wind farms.

at the BPNS is needed. Moreover, further studies should also handle the normalisation issue. As Al can be a contaminant at offshore wind farms, currently applied OSPAR normalisation with Al does not seem appropriate. Evaluation of different normalisation methods, based on sediment granulometry, mineralogy or a combination of both will be essential in future research.

A more in-depth study on a broad selection of metals, including In, and organic contaminants seems appropriate to further investigate pollution by other wind farm operation contaminants and/or to unravel the potential emissions of other chemical compounds from wind farms in the BPNS.

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